Electron cloud meeting #73, 24/01/2020 ([indico](#))

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Development of WARP simulations for 3D RF structures (L. Giacomel)

Lorenzo presented the development of WARP simulations for studying beam-induced multipacting in crab cavities:

- PyECLOUD would not be enough for these simulation due to the 3D nature of the problem and the presence of externally applied electromagnetic fields.
- A collaboration has been setup with LBNL to use the WARP code to perform the simulations.
- To model the electron multipacting it was decided to couple WARP to PyELCOUD (the interface has been developed by L. Giacomel, G. Iadarola, J-L Vay during Gianni's visit at LBNL in October). A detailed description of the interface is provided in the slides.
- Additional features including checkpointing and macroparticle regenerations needed to be implemented to make the simulations possible.
- The new setup has been successfully benchmarked against PyECLOUD for the case for a long dipole magnet.
- The geometry of the crab cavities was simplified to ease first tests. First simulations were performed with RF field imported from CST particle studio. The effect of the crabbing field on the bunches was verified.
- From first simulations using the electrostatic solver, inside the cavity the multipacting seems to be suppressed by the RF field.
- Development is continuing to allow for a full electromagnetic simulation of the cavity. A simple coupler consisting of a rectangular waveguide was introduced to feed the cavity. The waveguide is fed using WARP's "laser antenna".
- Next steps will consist in:
  - Studying more deeply the transient behavior of the rectangular waveguide;
  - Carrying out self-consistent simulations.

Ion energy spectrum for the LHC arcs (L. Mether)

Lotta presented a study on the behavior of ions in the LHC beam screens. The main finding were:

- Under nominal LHC vacuum conditions, ionization processes are insignificant for the electron cloud build-up process and for the heat loads on the beam screen

- The energy spectrum and current of the ion population produced through ionization have been estimated, to help determine if they can be relevant e.g. for the beam screen surface chemistry.
- Electron-induced ionization impacts the results only marginally.

Analysis of measurements from the LHC Vacuum Pilot Sector (E. Buratin)

E. Buratin presented the results of her measurement campaign at the LHC vacuum pilot sector:

- The Vacuum Pilot Sector (VPS) is able to detect EC and SR signals in the LHC.
- In the multipacting regime, the EC is observed to be linearly dependent on the number of bunches, and linearly dependent on the bunch population, above a certain threshold that defines the multipacting regime. The threshold at which the EC multipacting starts increases with the electron dose due to beam conditioning.
- A linear dependence on the bunch length is observed.
- The EC multipacting threshold can be identified in both electrical and pressure signals for ex-situ NEG and Copper.
- The comparison between different surfaces shows that amorphous carbon coating reduces drastically the EC build-up, thanks to its low SEY.
- The energy spectrum measured at 6.5 TeV shows a peak at 100 eV.
- The bunch pattern is observed to have a very strong effect on the measurements.
- In 2 years, at the copper surface the EC multipacting is reduced by five orders of magnitude at 450 GeV. The conditioning continues along the years.
- The amorphous carbon coating surface is found to be stable with time.

Laser treatments for SEY reduction (M. Himmerlich)

Marcel presented an overview on laser treatments for SEY reduction:

- The advantage compared to thin film technology is that it is selective and precise and can be performed in air or inert gas (vacuum not required)
- Performing the treatment in air results in strong surface oxidation (including charge up at cryogenic temperatures) Treatment in nitrogen prevents surface oxidation. For this reason all setups are designed to blow N_2 into the reaction zone.
- To reduce the impedance of the chamber the grooves need to be parallel to the beam direction.
- Tests with beam were performed at the SPS.
- A mole is being developed to treat LHC beam screens in situ.
- The SEY is rather uniform and conditioning is observed when the surface is bombarded with electrons.

- Dust is generated during the treatment. A vacuum extraction unit is applied but performance needs to be improved.
- A laser test bench has been setup at CERN in SMA-18.
- A concern for superconducting magnets is that particles are released in case of quench. This is being studied in collaboration with EPFL.